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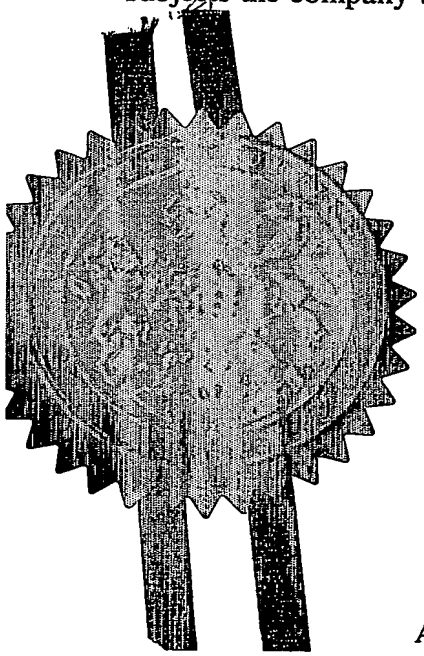

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0226842.3

16 NOV 2002

3. Full name, address and postcode of the or of each applicant *(underline all surnames)*

Mechadyne PLC
Park Farm Estate
Kirtlington
Oxon OX5 3JQ.

Patents ADP number *(if you know it)*

8025058002

If the applicant is a corporate body, give the country/state of its incorporation

United Kingdom

4. Title of the invention

Engine with Variable Lift Valve Mechanism

5. Name of your agent *(if you have one)*

"Address for service" in the United Kingdom to which all correspondence should be sent *(including the postcode)*

A. Messulam & Co. Ltd
43-45, High Road
Bushey Heath
Herts WD23 1EE

Patents ADP number *(if you know it)*

76362 10001

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Country	Priority application number *(if you know it)*	Date of filing *(day / month / year)*

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Number of earlier application	Date of filing *(day / month / year)*

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Claim *(s)*	3
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Signature: A. Messulam Date: 14/11/02

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ENGINE WITH VARIABLE LIFT VALVE MECHANISM

Field of the invention

The present invention relates to an internal combustion engine having a valve mechanism which comprises an exhaust or inlet poppet valve, a valve actuating rocker acting between a fixed point on the engine and the poppet valve, a camshaft having a cam for operating the valve, and a pivotable intermediate rocker having a follower acted upon by the cam and a contoured surface that acts on the valve actuating rocker to open and close the valve in synchronism with the rotation of the cam, the pivot point of the intermediate rocker being movable to vary the valve lift.

Background of the invention

The known BMW Valvetronic valve mechanism operates in the manner described above and is believed to constitute the closest prior art to the present invention. In the known mechanism, the intermediate rocker pivots about a point at its upper end which can be moved from side to side by means of a cam. At a point between its two ends, the intermediate rocker carries the cam follower, its lower end being contoured and in contact with the valve actuating rocker.

A first disadvantage of the known mechanism is that the cam acting on the intermediate member to vary the valve lift is mounted higher in the engine cylinder head than the camshaft. The mechanism therefore requires a special cylinder head that increases the overall height of the engine and can cause packaging problems.

A further disadvantage of the known mechanism is that the intermediate member is not positively retained in the cylinder head and is merely allowed to free float, being

urged against its various contact points (at the cam and at its pivot) by means of a spring.

Summary of the invention

With a view to mitigating the foregoing disadvantages, the present invention provide an internal combustion engine as set out above, wherein the intermediate rocker is pivoted about a shaft of which the axis lies between the cam follower and the contoured surface and the shaft is mounted for movement along a path that maintains a substantially constant clearance between the contoured surface and the valve actuating rocker when the cam follower is on the base circle of the cam.

In the present invention, the intermediate rocker is mounted on a shaft and is therefore positively retained in the engine. Furthermore, because the intermediate rocker is not pivoted at one end but at a point between the cam follower and the contoured surface, the pivot shaft is located lower in the engine, avoiding the need to increase the overall height of the cylinder head. This also has the effect of reducing the rotational inertia of the intermediate rocker.

It is also important to note that whereas in the prior art the intermediate member pivots about a single point at its upper end, in the present invention the intermediate rocker is pivoted about a shaft and it therefore less prone to wear.

The valve actuating rocker preferably comprises a roller follower in contact with the contoured surface of the intermediate rocker, though it is alternatively possible to provide a part-cylindrical contact surface in place of the roller. In order to maintain a constant clearance between the valve actuating rocker and the contoured surface of the

intermediate rocker, it is preferred to provide a link to constrain the pivot shaft of the intermediate rocker to move in an arc centred on the axis of the roller or cylindrical contact surface of the valve actuating rocker.

In order to move the pivot shaft of the intermediate rocker, it is preferred for the shaft to pass through a bore in an eccentric sleeve rotatably supported in a stationary bearing block of the engine. The rotation of the eccentric sleeve will in this case result in translation of the axis of the shaft.

The eccentric sleeve is advantageously coupled to the shaft by means of a pin which is free to slide relative to at least one of the sleeve and the shaft. In practice, the shaft will normally be supported in at least two bearing blocks and by rotating the shaft, all the sleeves will be moved by equal amounts.

The moving the pivot shaft of the intermediate rocker will not only result in the valve lift being varied but in a change in the timing of the valve event. It is possible to provide a phase change mechanism between the engine crankshaft and the camshaft to compensate for this modification of the engine timing if it is not desired.

Conveniently, the fixed point on which the valve actuating rocker rests in the engine comprises a hydraulic tappet.

Brief description of the drawings

The invention will now be described further, by way of example, with reference to the accompanying drawings, in which :

Figure 1 is a perspective view of the valve mechanism of an engine of the present invention,

Figure 2 shows an end view of the valve mechanism of Figure 1 with the valve closed and the pivot shaft of the intermediate rocker in a position to achieve maximum valve lift,

Figure 3 shows an end view similar to that of Figure 2, with the valve fully opened and the pivot shaft of the intermediate rocker in a position to achieve maximum valve lift,

Figure 4 shows an end view similar to that of Figure 2, with the valve closed and the pivot shaft of the intermediate rocker in a position to achieve minimum valve lift, and

Figure 5 shows an end view similar to that of Figure 2, with the valve fully opened and the pivot shaft of the intermediate rocker in a position to achieve minimum valve lift.

Detailed description of the preferred embodiment

The valve mechanism in the drawings is fitted to a cylinder head of an engine which, in the interest of clarity has not been shown in full. A camshaft 10 is suitably journalled in the cylinder head and carries cams 12. The cams 12 act by way of the mechanism to be described below on two poppet valves 14. Each poppet valve 14 is slidable in a valve guide 16 that is driven into the cylinder head. When the valve is closed by a spring which is not shown, the enlarged head of the valve 14 seals, against a valve seat 18 that also forms part of the engine cylinder head.

Each valve 14 is opened and closed by a valve actuating rocker 20, herein termed the first rocker, which is pivoted at one end on a hydraulic tappet 22 (shown in Figures 2 to 5). The opposite end of the first rocker 20 acts on the upper end of the stem of the valve 14 and a follower roller 24 is fitted to the first rocker 20 near its mid-point.

An intermediate rocker 30, herein termed the second, rocker, is pivotably mounted on a shaft 32. One end of the second rocker 30 carries a cam follower roller 34 and on its opposite end there is formed a contoured surface 36 which acts on the follower roller 24 of the first rocker 20. As the cam 12 rotates, the second rocker pivots about the shaft 32 and its contoured surface 36 acts on the roller 24 to pivot the first rocker 20 about the hydraulic tappet 22 and thereby open and close the valve 14.

Because of the shape of the contoured surface 36, movement of the pivot shaft 32 from left to right as viewed in Figures 2 to 5 has the effect of reducing the valve lift. This can best be seen from a comparison of Figures 2 to 5.

In Figure 2, the roller 24 is in contact with the contoured surface mid-way along its length when the cam follower roller 34 is in contact with the base circle of the cam 12. When the roller 34 moves on to the lobe of the cam 12, as shown in Figure 3, the right hand end (as viewed) of the contoured surface 36 fully depresses the first rocker 20 to open the valve with maximum lift.

By contrast, in Figure 4, the pivot shaft 32 has been moved to the right so that when the roller 34 is on the base circle of the cam 12 the follower 24 is in contact with the contoured surface 36 near its left hand end. When, as shown in Figure 5, the roller 34 moves on to the lobe of the cam 12, the follower 24 does not reach the right hand end of the contoured surface 36 and the valve is not opened to the same extent. Thus by moving the pivot shaft 32 from left to right, as viewed, the valve lift can be set to any desired value between its two limits.

It is important to ensure that the act moving the shaft 32 to vary the valve lift does not affect the clearance between the roller 24 and the contoured surface 36. For this

clearance to remain constant, the locus of the shaft 32 is required to be an arc centred on the axis of the follower roller 24.

In the illustrated embodiment of the invention, the shaft is constrained to move along such a path by means of a pair of links 38. The shaft 32 is rotatably mounted in the latter links 38 and the lower end of each link 38 is pivotably mounted on a respective pivot pin that is stationarily mounted in the engine with its axis in line with the axis of the follower rollers 24 of the first rockers 20. Each pin projects from a small block 40 that is bolted to a post 42 which forms part of the engine cylinder head.

The shaft 32 passes through two cylindrical bores formed in bearing blocks (not shown) which are secured to the engine cylinder head. Sleeves 44 with eccentric bores are interposed between the shaft 32 and the bearing blocks, the shaft 32 being received with clearance in the bores of the sleeves 44. Each sleeve 44 is coupled for rotation with the shaft 32 by means of a pin (not shown) which is a sliding fit in at least one of the shaft 32 and the sleeve 44.

If the shaft 32 is rotated, the eccentric sleeves 44 will rotate in the bearing blocks and thereby displace the axis of the shaft. The clearance between the shaft 32 and the sleeves 44 and the sliding movement of the coupling pins are required because the path followed by the shaft 32 is dictated by the links 38 and not by the sleeves 44. The eccentric sleeves 44 serve merely as a convenient manner to urge the shaft 32 to the left or to the right uniformly along its length.

If desired, a phase changing mechanism of any suitable design (of which there are numerous examples in the prior

art) may be used to vary the phase of the camshaft 10 in relation to the engine crankshaft. Such a phase change mechanism may, for example, be used to compensate for the variation in event timing that accompanies the variation in valve lift achieved by the mechanism described.

It will be appreciated by the person skilled in the art that various modifications may be made to the described valve mechanism without departing from the scope of the invention as set out in the appended claims. For example, in the described embodiment, separate cams and intermediate rockers are employed to open the two valves of a cylinder, but it would be alternatively possible to employ a single intermediate rocker having a single cam follower and two profiled surfaces to act on the two valves. Such a construction permits both valves to be actuated concurrently by a single cam lobe.

As above described, the cam lobes 12 and the contoured surfaces 36 associated with the respective valves were assumed to be identical so that the two valves of a cylinder would always open at the same time and by the same amount as one another. It is alternatively possible however for the cam profiles and/or the contoured surfaces of the intermediate rockers actuating the two valves to have a different geometry from one another, such that the valve lift characteristics of the two valves differ from one another as the valve lift is reduced.

CLAIMS

1. An internal combustion engine having a valve mechanism which comprises

an exhaust or inlet poppet valve,

a valve actuating rocker acting between a fixed point on the engine and the poppet valve,

a camshaft having a cam for operating the valve, and

a pivotable intermediate rocker having a follower acted upon by the cam and a contoured surface that acts on the valve actuating rocker to open and close the valve in synchronism with the rotation of the cam,

characterised in that

the intermediate rocker is pivoted about a shaft of which the axis lies between the cam follower and the contoured surface, and

the shaft is mounted in the engine for movement along a path that maintains a substantially constant clearance between the contoured surface and the valve actuating rocker when the cam follower is on the base circle of the cam.

2. An engine as claimed in Claim 1, wherein the valve actuating rocker comprises a roller follower in contact with the contoured surface of the intermediate rocker.

3. An engine as claimed in Claim 1, wherein the valve actuating rocker comprises a part-cylindrical contact surface in contact with the contoured surface of the intermediate rocker.

4. An engine as claimed in claim 2 or 3, wherein a link is provided to constrain the pivot shaft of the intermediate rocker to move in an arc centred on the axis of the roller or cylindrical contact surface of the valve actuating rocker.

5. An engine as claimed in any preceding claim, wherein the pivot shaft of the intermediate rocker passes with clearance through a bore in an eccentric sleeve rotatably supported in a stationary bearing block of the engine.

6. An engine as claimed in claim 5, wherein the eccentric sleeve is coupled to the shaft by means of a pin which is free to slide relative to at least one of the sleeve and the shaft.

7. An engine as claimed in any preceding claim, wherein a phase change mechanism is provided between the engine crankshaft and the camshaft.

8. An engine as claimed in any preceding claim, wherein the fixed point on which the valve actuating rocker rests in the engine comprises a hydraulic element.

9. An engine as claimed in claim 8 when appended to claim 2 or 3, wherein the pivot shaft of the intermediate rocker is mounted for movement along a path that is not an arc centred on the axis of the roller or cylindrical contact surface of the valve actuating rocker and the hydraulic element is operative to compensate for small changes in clearance.

10. An engine as claimed in any preceding claim, wherein the intermediate rocker has a single cam follower and two profiled surfaces to act on two valves of the same engine cylinder, such that both valves are actuated concurrently by a single cam lobe.

11. An engine as claimed in any preceding claim, wherein each engine cylinder has two valves actuated by the valve mechanism, and wherein the cam profiles and/or the contoured surfaces of the intermediate rockers actuating the

two valves have a different form, such that the valve lift characteristics of the two valves differ from one another as the valve lift is reduced.

12. An internal combustion engine having a valve mechanism substantially as herein described with reference to and as illustrated in the accompanying drawings.

ABSTRACT

ENGINE WITH VARIABLE LIFT VALVE MECHANISM

An internal combustion engine is described having a valve mechanism which comprises an exhaust or inlet poppet valve 14, a valve actuating rocker 20 acting between a fixed point on the engine and the poppet valve 14, a camshaft 10 having a cam 12 for operating the valve 14, and a pivotable intermediate rocker 30 having a follower 34 acted upon by the cam 12 and a contoured surface 36 that acts on the valve actuating rocker 20 to open and close the valve in synchronism with the rotation of the cam. The intermediate rocker 30 is pivoted about a shaft 32 of which the axis lies between the cam follower 34 and the contoured surface 36 and the shaft 32 is mounted in the engine for movement along a path that maintains a substantially constant clearance between the contoured surface 36 and the valve actuating rocker 20 when the cam follower 34 is on the base circle of the cam 12.

Figure 1.

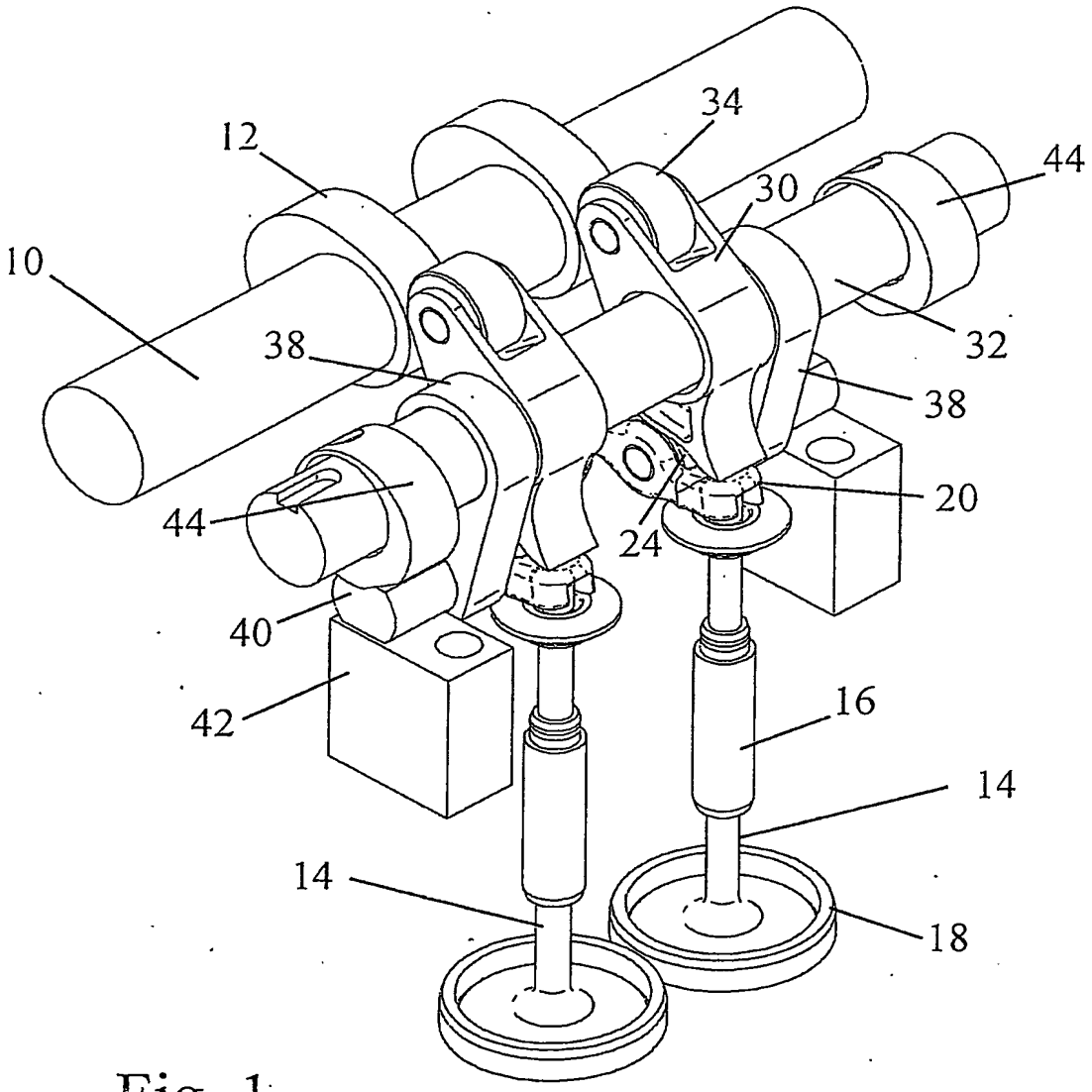


Fig. 1

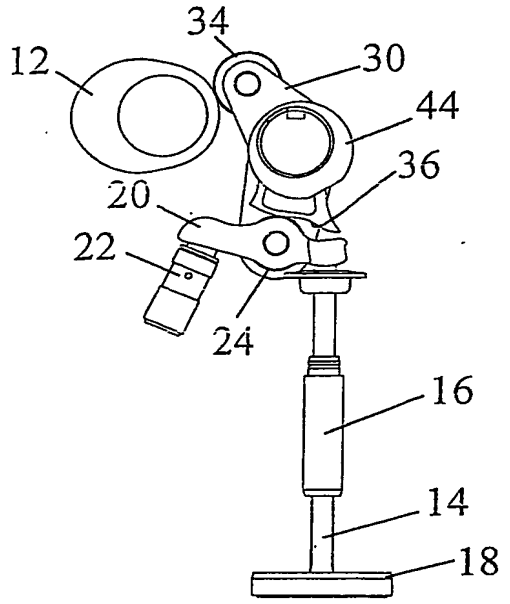


Fig. 2

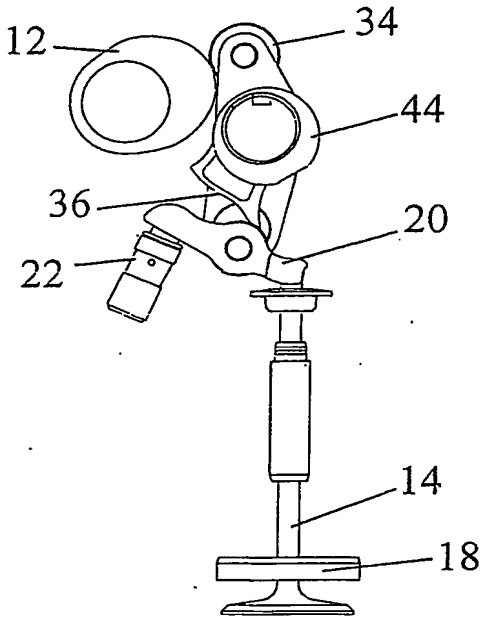


Fig. 3

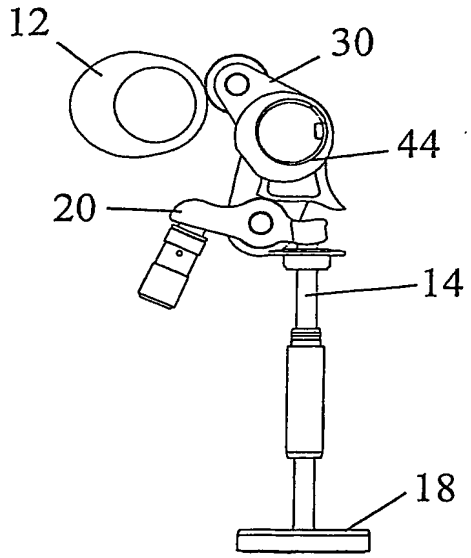
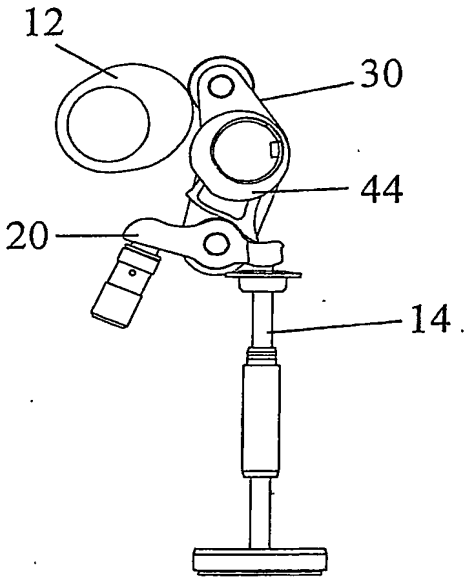


Fig. 4



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